DOCUMENT RESUME

ED 348 005 IR 015 742

AUTHOR Knupfer, Nancy Nelson; Clark, Barbara I.
TITLE Tessellating with Logo: Effects on Visual Literacy.
PUB DATE Feb 92
NOTE 12p.; In: Proceedings of Selected Research and Development Presentations at the Convention of the Association for Educational Communications and Technology and Sponsored by the Research and Theory Division; see IR 015 706.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Analysis of Variance; *Art Activities; *Computer Graphics; Elementary Education; *Geometric Constructions; Grade 2; Grade 6; *Pattern Recognition; Pretests Posttests; Programing Languages; Skill Development; Thinking Skills; *Visual Literacy
IDENTIFIERS *LOGO Programing Language; *Tessellations

ABSTRACT

This investigation of the potential of a Logo environment to develop visual literacy skills in elementary school students focused on the recognition of Escher-type geometric constructions by second and sixth grade students. Four research questions were addressed: (1) whether students can use higher-order and creative thinking skills in using computers to create mathematical tessellations and art; (2) whether they can create Escher-like tessellations using Logo; (3) whether this enhances their visual literacy and visual perception; and (4) whether they can transfer that knowledge when looking at the prints of M. C. Escher and describe the more obvious figures and underlying geometrical shapes within Escher's prints. The treatment group was made up of 110 second and sixth grade students, most of whom had not been exposed to Logo, and the control group numbered 126 students in the two grades. A pretest and posttest were conducted using Escher prints. No significant differences in figure and geometric shape identification were found among the student groups on the pretest. Students in the experimental group used LogoWriter (LCSI) to practice creating and tessellating shapes following an introductory paper and pencil exercise, and additional information on Escher was made available to them. Analyses of the final data showed that sixth grade students identified significantly more shapes than did second grade students, and those in the treatment groups identified more shapes than those in the control groups. Further, the older students who received the treatment identified the most geometric shapes. Based upon the observed performance and the generally positive attitude of the students, along with the changes in their ability to see geometric constructions with a piece of artwork, it is concluded that using Logo can be helpful in promoting visual-spatial awareness. (9 references) (BBM)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED348005

Title:

Tessellating with Logo: Effects on Visual Literacy

Authors:

Nancy Nelson Knupfer
Barbara I. Clark

1201574 2

BEST COPY AVAILABLE

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Michael Simonson

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Tessellating with Logo: Effects on Visual Literacy

Nancy Nelson Knupfer, Ph.D.
Kansas State University

Barbara I. Clark
Arizona State University

Educational computing offers a wealth of opportunities to teach through the use of one's visual sense. That visualization can be used to develop higher-order thinking skills in a way that is quite different from a text-based approach to teaching and learning. Yet, the content of many computer-based lessons and their accompanying images on the screen often neglect this potential mode of teaching. This paper reports a study that investigated the potential of the Logo programming language to develop visual literacy skill in elementary school students.

PURPOSE

The purpose of this research was to investigate the potential of a Logo environment to develop visual literacy and recognition of Escher-type geometric constructions within second grade and sixth grade students. Specifically, the following questions were asked. Can students use higher-order and creative thinking skills in relation to using computers to create mathematical tessellations and art? Can students create Escher-like tessellations using Logo? Does this enhance their visual literacy and visual perception? Can students transfer that knowledge when looking at the prints of M.C. Escher and describe the more obvious figures and the underlying geometrical shapes within Escher's prints?

BACKGROUND

Through the cognitive and organizational processes of thinking, one develops literacy in the visual and verbal domains. "Visual literacy is the active reconstruction of past visual experience with incoming visual messages to obtain meaning" (Sinatra, 1986, p. 5). Visual information is sent to the brain where it is interpreted and modified in light of past experiences. This process begins early in life and precedes or develops concurrently with oral literacy (Sinatra, 1986).

Visual literacy is the ability to not only understand paintings, photographs, film, and other visual media, but also the ability to communicate or express oneself with at least one visual medium (Curtiss, 1987). It draws its meaning from the way one thinks visually, creates new knowledge, and uses thinking skills beyond those which are basic in the approach to learning. These skills often employ higher-order thinking which challenges the traditional path of problem solving and applies different approaches to learning. These different approaches call upon different learning styles as each situation demands.

Our visual awareness, which is how we see, and our visual perception, which is how we view objects of nature and their relationship to the space around them, help us to seek, uncover and construct new ideas. For centuries, nature and its objects have been viewed from the constructs of Galileo's "geometricizing physics" (Jones, 1989, p. 8). Within this construct nature is perceived solely in terms of its geometrical patterns and mathematical physics.

Geometry, for example, has provided a systematic method of understanding shapes and their transformation within space.

To have an understanding of shapes within space is a "perceptual consciousness" (Jones, 1989, p. 124). An awareness of spatiality is vital and important in creating new knowledge. Just as nature has been defined for centuries by scientists and mathematicians, so too have artists visualized objects in space through their paintings, sculptures, and other media. They discover space through artistic expression rather than mathematical induction.

But artists and mathematicians rarely mix their discoveries. As forms of expression, the arts and mathematics have not been assimilated by artists or scientists. This is often due to the unwritten doctrine that artists should not practice intellectuality in their work (Locher, 1988).

Escher, however, combined the ideas of the empirical world as an illusion with mathematical representations of that world. The mathematics represented the unifying principle upon which a work was constructed and arranged (Thornburg, 1983). Escher's prints conveyed his ability to balance perfect forms and structures with the idea that everything is simply an illusion (Locher, 1988). These artistic renderings of illusory geometric shapes rotating about a point in space generate a mathematical beauty which has the ability to please the senses and elate the mind of the viewer.

Viewing Escher's works, appreciating Escher's vision and mathematical ideas, and being able to describe what is visually present requires conceptual thinking. Arnheim (1974) describes this form of reasoning as an artistic activity and claims that the process calls upon perception and thought which are intertwined in an indivisible manner. He posits that our senses employ impressions and experiences from which we form perceptions, which we then express through our thoughts. Arnheim indicates three elements that are necessary for human cognition: common characteristics that control perception in the nervous system and its reflections upon consciousness; constructing physical reality through the senses; and the properties inherent in media through which cognitive experiences take place (Arnheim, 1986). This process of visual conception is formed by one's intent, creative resourcefulness, and fresh ideas (Curtiss, 1987). Through this process of visual thinking we are able to evaluate our visual experiences and make visual statements regarding our perceptions.

Being visually literate is tantamount to being educationally well-rounded as a person. This premise has major implications for educators and the curriculum. According to Arnheim (1986), visual thinking promotes a continuous link between pictures and words, and between the arts and sciences. These links extend more broadly to encompass both language and images, as well as perceptual experience and theoretical reasoning. And because the structural properties of images, symmetry for example, drive the thinking, Arnheim advocates that teachers use specific rules related to pictorial composition and visual order when presenting new geometry concepts to students. Thus, students will be encouraged to think in terms of visual images.

Visual thinking as a primary medium of thought can be defined as having three components which include perceptual images, mental images, and graphic images (Erikkson,1988). Perceptual images are the ways we choose to see and interpret the external world. Mental images are the ways we invent, envision, create ideas to solve problems and integrate information. Graphic images are the visual codes and languages we use to communicate information.

According to Eriksson (1988), the visual nature of communication and the fact that visual images are the building blocks of data require a new language based upon verbal-visual cues. This requires educators and curriculum designers to emphasize visual literacy skills.

The computer has the potential to offer instruction based upon visualization. For example, images created on the computer screen can enhance the meaning of lessons. In addition particular software which is based upon visualization may have the potential of helping students develop visual literacy skills. For example, Logo uses visual elements which show students the results of structured procedures that they write. Knupfer (1991) recently reported some interesting patterns of increasing cognitive skill related to spatial scanning among students who used Logo during group activity. This research investigates the possibility that using Logo will help students develop visual literacy skills and spatial scanning as it relates to Escher-like tessellations.

METHOD

Subjects

Four classes of students participated in this study: two classes of second grade students and two classes of sixth grade students, totalling 110 students. All classes were heterogeneously mixed. One teacher instructed both second-grade classes and another teacher instructed both sixth-grade classes. None of the second graders had experience with Logo prior to this study, and approximately half of the sixth graders had been exposed to Logo during the previous school year.

A control group of 126 students was used; again, there were two classes of second-grade students and two classes of sixth-grade students. The control group was from a different school within the same geographical region and consisted of a similar population of students. The control group did not receive the Logo treatment and practice.

Tables one, two and three should the breakdown of subjects by treatment and control, grade level, gender, and racial group.

Materials

Pretest and Posttest. A pretest and posttest were conducted using Escher prints. Two prints were used for the pretest and three different prints, which had similar qualities in terms of this study, were used for the posttest. All prints had one or two figures and one geometric shape upon which the print was constructed. The pretest and the posttest each contained two colored prints along with one black and white print.

Software. LogoWriter (LCSI) was used as the software with which students practiced creating and tessellating shapes. The students created all geometric shapes, patterns, and tessellations within this software environment with the exception of one paper and pencil exercise that served as an introduction to the concept of tessellations. Use of the Logo language allowed the students to work within a microworld as Papert envisioned.

Escher Artwork. Samples of Escher artwork were displayed in the computer laboratory where the students had their classes. Also, a few books on Escher were placed within the school library for the students to check out.

Table 1. *Subjects by Grade and Treatment*

GRADE	TREATMENT	CONTROL	TOTAL
2nd	48	55	103
6th	64	71	135
TOTAL	112	126	238

Table 2. *Subjects by Grade and Gender*

GRADE	MALE	FEMALE	TOTAL
2nd	46	57	103
6th	70	65	135
TOTAL	116	122	238

Table 3. *Subjects by Racial Group*

	CAUCASIAN	HISPANIC	BLACK
COUNT	143	85	10
PERCENTAGE	60.1	35.7	4.2

Paper and Felt-tip Pens. One class period called for the introduction of tessellations using a paper-based activity in which the students created tessellations and colored patterns within them.

Procedure

This study was conducted during an entire spring semester; students used computers in a laboratory setting for one 40-minute session during each week. Most of the students worked in preassigned pairs. Students were individually pretested using two Escher prints. They were asked to describe the recognizable figures and geometric shapes that they saw in the prints.

Next, the students received instruction in creating shapes using the LogoWriter software. They were taught commands to first create the shape and then to write a procedure for constructing the shape. Initially, shapes were limited to squares, triangles, and hexagons so that students could tessellate their work. Once students mastered writing procedures, they were taught the MOVE command and practiced tiling their shapes vertically or horizontally on the screen. Finally, students were asked to tessellate their shapes and fill the screen with the tessellations.

In accordance with research on transfer of knowledge, once the foundations were laid, the students were given instruction on Escher prints and the Escher style of creating tessellations. Approximately twelve weeks into the study, one researcher taught a lesson to familiarize the students with Escher and the concept of tessellations within artwork. During a single class period, the students were shown examples of Escher artwork and were able to look for the figures and geometric shapes within it. Both the treatment and the control group were taught the Escher lesson, but the control group simply heard the lesson and received no ability to practice applying its concepts. On the other hand, after hearing the presentation and seeing some examples, the students in the treatment group were able to try creating a tessellation by first drawing a plan on a piece of paper and trying to create that plan on the computer.

During the final three weeks of the unit the sixth-grade students who had already mastered tessellating the computer screen with standard geometric shapes, were able to try more a more complicated task. Those students wrote procedures which pushed in and pulled out the sides of a square as part of the process of creating Escher-like shapes on the computer. Figure 1 shows an example of this type of work. The shape stands alone as it was created and then it is incorporated in a tessellating pattern. Students who were able to create more complicated patterns went on to design fancier tessellations like the one pictured in Figure 2.

The students continued to practice tessellating their shapes, printed the full-screen tessellations on paper, and drew Escher-like figures on their printouts with colorful felt-tip pens. Finally, the students were posttested using three additional Escher prints that they had not seen before. The posttest followed the same method as the pretest and the only variable was fresh prints to avoid the recognition of previous viewings. The control group received no Logo instruction and were simply given the pretest and posttest.

Teaching Style. The second-grade students were taught by one second-grade teacher who had previously worked as a computer lab teacher. The sixth-graders were taught by the current computer lab instructor. Both instructors were knowledgeable in the use of computers and LogoWriter. Their approaches to teaching with computers were similar, but their teaching styles were not. The second-grade teacher's style was gregarious, animated, and experientially oriented while the sixth-grade teacher's style was structured, linear, and oriented toward rote learning.

Figure 1
Shape and Tessellation of a Pushed In and Pulled Out Square

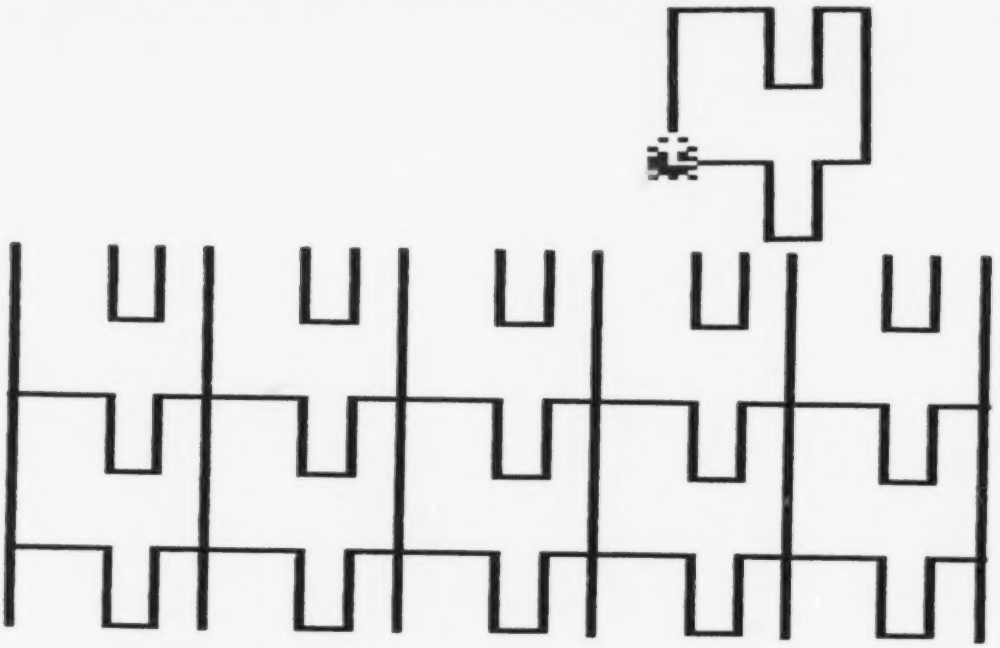
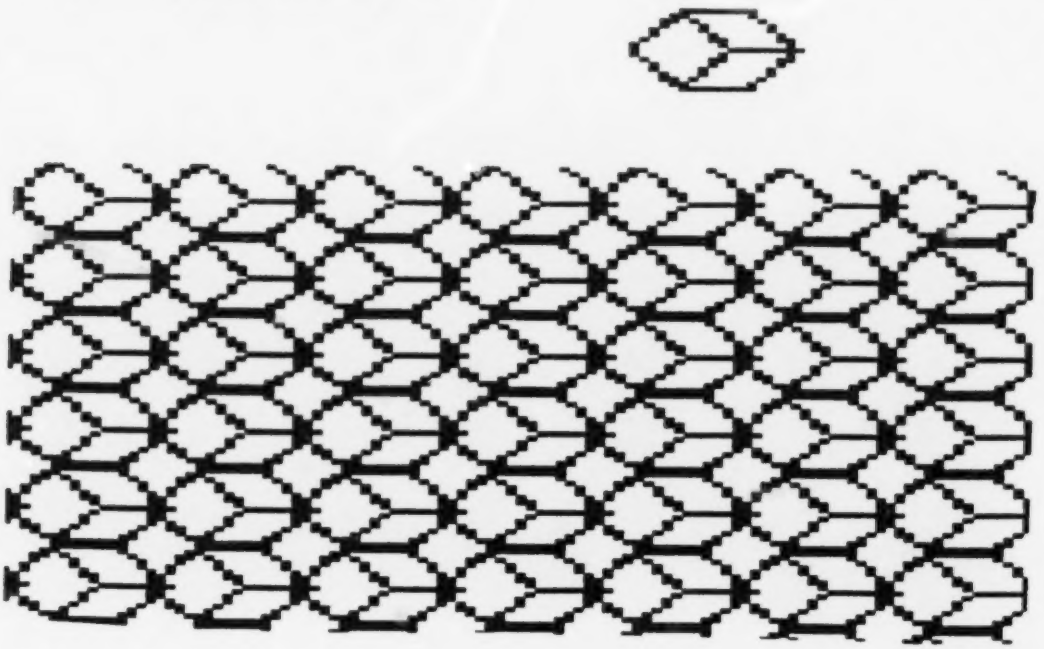


Figure 2
Shape and Tessellation of a Cube



Prior to beginning the Logo instruction, both teachers were given a script to guide them through the weekly lessons. The second-grade teacher began by following the script but changed the script in consultation with the researchers when he felt the students needed more time to work on understanding particular concepts, such as how to make the turtle move or the meaning of tessellation. The sixth-grade teacher followed his own course of study with the unit and ignored the script from the beginning.

Analysis

The independent variables for analysis were Logo treatment and grade level. The dependent variables were figure and geometric shape identification. ANOVA determined that there were no significant differences in the pretest scores for either figure or shape identification among the student groups. The posttest scores were analyzed using a 2 X 2 ANOVA (grade level by treatment group) and t-test between treatments within each grade level. The analysis, which follows, allowed some conclusions to be drawn about the feasibility of using Logo to enhance visual literacy and spatial scanning skills which might transfer to the ability to recognize Escher-type geometric patterns of figures and shapes. The alpha level for significance was set at .05.

RESULTS AND CONCLUSIONS

There were two dependent variables in question for the analysis; figures and geometric shapes. Table 4 lists the means and standard deviations for The ANOVA for figure identification revealed significant main effects for both treatment and grade, but no significant interactions (see Table 5). One could interpret this to mean that the students who received the Logo practice did better than those who did not receive Logo. In addition students in the sixth grade recognized more figures than did the second grade students. However, there is no interaction between those main effects.

The ANOVA for geometric shape identification revealed significant differences for the main effects as well as an interaction between the independent variables of treatment and grade (see Table 6). This indicates that sixth grade students identified significantly more shapes than did second grade students, and those in the treatment group identified more shapes than those in the control group. Further, the older students who received the treatment identified the most geometric shapes.

Student Attitudes. Throughout the study the students remained interested in the daily tasks. The second-graders experienced some frustration, but because the teacher was alert to its signs, adjustments were made to the lessons which allowed students to proceed at a more comfortable level. The sixth graders demonstrated various levels of enthusiasm. Some students worked ardently, while others did not remain on task.

Once the students began to be successful with the tessellations, their interest level increased; this was true of both grade levels. After the lesson on Escher and his artwork, the students showed a remarkable interest in the activity. Some second graders were heard to remark that they were going to "play artist" after school and some of the sixth graders checked out books on Escher from the library. Students at both grade levels wanted to know where they could find other things by Escher. For example, the researcher had shown the students a tote bag, some wrapping paper, and some posters contained Escher prints, and the students wanted to buy some of those things for themselves. They were also interested in finding more books about Escher at the public library.

Table 4. *Means and Standard Deviations on Posttest*

		FIGURES		GEOMETRIC SHAPES	
GROUP	n	M	SD	M	SD
2nd Grade Treatment	48	2.71	.62	1.35	1.02
2nd Grade Control	55	2.45	.86	.18	.51
6th Grade Treatment	64	2.92	.42	2.12	.88
6th Grade Control	71	2.85	.32	0.30	.52

Table 5. *ANOVA for Figure Identification (Treatment by Grade)*

Source	D.F.	Sum of Sq.	Mean Sq.	F Ratio	F Prob.
Treatment (A)	1	1.30	1.30	3.95	.048*
Grade Level (B)	1	5.79	5.79	17.66	.000*
Treatment X Grade (AB)	1	.53	.53	1.62	.204
Error	234	76.75	.33		
Total	237	84.37	.36		

* = Significant at the $<.05$ level

Table 6. *ANOVA for Geometric Shape Identification (Treatment by Grade)*

Source	D.F.	Sum of Sq.	Mean Sq.	F Ratio	F Prob.
Treatment (A)	1	142.19	142.19	254.10	.000*
Grade Level (B)	1	10.42	10.42	18.62	.000*
Treatment X Grade (AB)	1	6.28	6.28	11.21	.001*
Error	234	130.95	.56		
Total	237	289.84	1.22		

* = Significant at the $<.05$ level

Based upon the observed performance and attitude of the students along with the changes in their ability to see geometric constructions within a piece of artwork, it appears that using Logo can be helpful in promoting visual-spatial awareness. This is particularly true at the sixth grade level. Even though the second graders were not able to create tessellations by building shapes from scratch on the computer, they did get the experience of creating the tessellations within Logo by using the shapes page and the SHADE command, so the end result was similar. They also were able to view the computer screens of their peers to discuss which ones tessellated and which ones did not.

Even these young students were able to improve their performance on the posttest. T-tests on the total group of second grade students revealed that second graders in the treatment group scored significantly better in recognizing both figures and geometrics shapes (see Table 7).

Table 7. *T-Test between Control and Treatment Groups of Second Grade Students*

Group	n	Mean	SD	SE	F Value	2-Tail Prob.
Figures						
Control	55	2.45	0.86	0.12	1.93	0.02
Treatment	48	2.71	0.62	0.09		
Geometric Shapes						
Control	55	0.18	0.51	0.06	3.97	0.00
Treatment	48	1.35	1.02	0.15		

Significant at the $<.05$ level

Students in this study seemed to have a positive attitude about this unit. While some students struggled with the assignments and were not able to complete the on-screen tessellations, others created Escher-like designs, thus accomplishing the overall objectives of the unit.

In this case the choice of teachers, the amount of weekly time spent in the computer lab and duration of this study were controlled by the school schedule. Although it is practical to conduct a study within the confines of the daily school routine this situation places limitations on the research. It would be helpful, for instance, to use the same teacher for both grades to eliminate teacher variability. Even though this study tried to control for teaching technique by scripting the lessons, one teacher did not adhere to the script and used a teaching style that told answers to the students rather than challenging the students to discover the answers. This makes it difficult to have absolute confidence in comparisons between the grade levels.

Although schools tend to focus on activities that use left brain or language processes more than right brain processes, many students do function very well, or even better, using the artistic element promoted by the right side of the brain. If Logo is valuable in aiding

development of visual literacy, then it certainly can benefit students at the lower and upper elementary grade levels.

Further research should be conducted using this study as a pilot test. Such research would be most helpful if it encompassed a longer period of time for the activities in the unit, particularly at the second-grade level. The second graders probably need a full school year to accomplish the objective of learning to tessellate figures from scratch within the Logo language. A longitudinal study might also include the question of how the combination of computers and art over time affects students attitudes toward the visual arts.

REFERENCES

Arnheim, R. (1986). *New essays on the psychology of art.* Berkeley: University of California Press.

Arnheim, R. (1974). *Art and visual perception.* Berkeley: University of California Press.

Curtiss, D. (1987). *Introduction to visual literacy: a guide to the visual arts and communication.* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Erikkson, G. (1988). Thinking in visual images in the information age -- the changing faces of the school. *Gifted Education International, 5*(1), 97-103.

Jones, E. (1989). *Reading the book of nature: a phenomenological study of creative expression in science and art.* Athens, OH: Ohio University Press.

Locher, J. L. (Ed.) (1988). *The world of M. C. Escher.* New York: Harry N. Abrams.

Knupfer, N. N. (1991). The effects of student ability grouping on transfer of knowledge and cognitive gains in a Logo environment. Paper presented at the annual meeting of the American Educational Research Association (AERA). Chicago, IL. April 3-7.

Sinatra, R. (1986). *Visual literacy connections to thinking, reading and writing.* Springfield, IL: Charles C. Thomas.

Thornburg, D. D. (1983). *Discovering Apple Logo: an invitation to the art and patterns of nature.* Reading, MA: Addison-Wesley.